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THE HUMAN COLOR-SENSE CONSIDERED AS THE ORGANIC RESPONSE TO NATURAL STIMULI.

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Were one a Comtist student of light and color, he could point to no branch of human knowledge, illustrating, at least so far, more appositely than that of chromatics, his master's three-fold division of the states of science, into "theological, metaphysical and positive." For untold ages men had worshiped the sun, the stars, fire, light, with all degrees of intellectual abjection, or intellectual perfection, from the lowest fetichism of a savage, to the most idealized symbolism of a Dante, before the subtile but simple conception of the undulatory nature of light, or the "metaphysical" explanation, occurred to the mind. Thanks to the labors of many great students and profound thinkers in the past three hundred years, we are now in the clear as to this second stage; the physical causes of vision are quite decisively settled; the causes of ether-waves, the laws of their action and propagation, their measurements and powers, have all been made out, and there is probably little left in this direction to discover. Men's minds therefore turn to the "third stage", and try to show the relations, successions and resemblances of these to other phe-

nomena. But here the Comtist theory meets a check; modern science has advanced the sphere of its activity and work into regions undreamed of, and wholly discountenanced by Comte's scheme. We are not content to study external phenomena *per se*, however wide the relations established. No science of today is content to see forces disappearing behind the Isis-curtain of the mind, and other and transmuted forces reappearing from that veiled sanctuary, without seeking to push aside that curtain, and learn what is the mystery there. So it is that all knowledge has remotely or directly a vital interest in those new methods of research, inaugurated by evolution and controlled by exact science, which we call physiological psychology, or psychiatry. It is found that no study of the relations of diverse phenomena is for a moment complete or satisfactory without psychological phenomena are included. Tyndall enjoins: "The roots of phenomena are imbedded in a region beyond the reach of the senses, and less than the root of the matter will never satisfy the scientific mind." Only by thus extending the scope and extent of the relations of phenomena to those of physiology and psychology can the Comtist's third stage include the recent development of light-studies.

In following along the path of light in its progress toward the brain, it was but natural that the eye should have arrested the attention of students, and that the advance of optical studies should have been stopped till its mechanism and powers had been duly apprehended. Moreover, if the intricacy and marvelousness of its construction be considered, it is all the more natural that, so long as its function remained mysterious, the crux of the whole problem of vision should have been lodged in it. In this way arose the idea of its specific functions, and from Herschell and Newton, to Young, Helmholtz, Hering and Preyer, the retina has been supposed to have a differentiating and specific energy, whereby the phenomena of chromatic sensation were explainable. Gradually, however, it is becoming plain that the retinal end-organs, as well as those of other senses, have no such power; instead of this the retinal function must be held as simply correlating the physical stimuli with the psychic reaction, and without power to create specific differences in the

stimuli received by it. Some of the grounds of this new envisagement of the phenomena are to be found in Wundts' now classical work; other statements of the same necessity are expressed in articles by H. M. Burnett, M. D., in the *American Journal of Medical Sciences* for July, 1884, by C. A. Oliver, A. M., M. D., in the same journal for January, 1885, and by the writers of the present article in the July 1886 number of the AMERICAN JOURNAL OF OPHTHALMOLOGY. We there try to advance a step, and give a nearer answer to the question as to the more intimate nature of the retinal process. We described it as a refined and delicate perception of thermal differences, if not identical, certainly not dissimilar from the function of the peripheral sensory end-organs. The facts of physics and physiology seemed to demand the supposition of a retinal intermediate, vibrating in correspondence with the varying wave-length of the ether, whose kinetic energies it transmutes into its own molecular activity, and the varying degrees or heights of this molecular activity are taken up by the cones and transmitted to the co-ordinating center for reworking into the cerebral products of color and light.

It was thus found that the result of this was to transpose the seat of the difficulty from the retina to the brain. Were we system builders, we might say that the progress of knowledge in regard to vision consists indeed of three stages: physical, physiological and psychical,—the first, in systematizing and formulating the laws of ethereal vibration; the second, in tracing the laws of the transmutation or causal relations of the ether-wave stimuli and the succeeding nerve-message; the third, in explanation of the transmutation of neural vibrations into the sensations of light and color. We have said the problems of the fiist stage are now answered. The difficulty encountered in the second was greatly increased by what we believe to have been the error of confounding it with the third. With its supposed specific function, the mind's work was given to the eye to do, and in trying to explain how it might do what it never did do, have resulted all the *de haute en bas* theories and illogicalities of ingenious *soi-disant* discoverers.

In the belief that greater clearness has been reached by elimi-

nating the idea of specific activity from the retinal function, and particularly in regarding that function as essentially a refined perception of differences of molecular activity, we may think more justifiable any attempt to attack the mystery in its new home. We therefore purpose offering a few suggestions as to certain aspects of chromatics from the psychical stand-point, hoping to strike more natural lines of cleavage than has happened heretofore.

In order more precisely to make clear the design we have, let us for a moment hark back to our ether waves; this is all the more necessary since we would do away with the color producing agency of the retina, thus more than ever emphasizing the strict psychological nature of color. *En passant* remarked, it is a rather strange fact how little it has entered the popular imagination that no such thing as color exists outside of the mind. The writer shall not soon cease to regret his temerity in stating this fact to a college graduate and bank president not long since. The remark was met by the silence of dignity, but the ill concealed look of scorn and disgust thinly veiled my friend's thorough belief that I was a fool, or took him for one, in thus trying to guy him with such absurdities.

In a very few people there is a sort of vague compromise in a misty idea that the *eye* may have a little to do with the process, but in attempting to pull this poor support from under them, they would, like the banker, fly to "non-existent objectivity," rather than float in the thin air of "subjective certainty."

In the visible (interference) spectrum we have spread out before our eyes a band of ether waves, differing from each other only in their length and in the corresponding frequencies of their arrival. The wave-lengths, gradually, and without any breaks, vary from .00007604 cm. to .00003933 cm., while the frequencies extend in the same graduated way from about 395 to 764 millions of millions per second. We know that in these facts alone consist all the differences there are out there; color and light do not yet exist—that is, if a blind person could feel these taps separately upon his finger-ends, and count them, he would then know the sum total of the external phenomena. What we wish to call particular attention to is the unbroken

continuity and gradualness of change in this wave-scale. There are no great jumps from waves of one frequency to those of another above, but each glides gradually, and by slow changes into a frequency not greatly different from itself. But when the mind directs the eye to this band, an inconsequential result appears in consciousness. The spectral colors are not a continuously and imperceptibly changing ascent, but consists of a few large steps, or bands of colors, more or less perfectly marked off from each other by delimiting intermediate shades Within the same color step whose hue seems in all parts identical to the eye, the waves differ often by so much as from five to ten, or even more, millions of millions of vibrations per second. At other points several different tints, or even perfectly defined colors, are caused by no greater different vibrational periods. Again, certain of these colors have been called primary or elementary; but why they have any such a quality, and why the spaces they occupy are relatively so great, and so different in extent as they are—these, with others to follow, are questions we have never heard asked, and so, of course, have never seen any attempts to answer. Yet these are the very queries that arise unbidden in the mind upon looking at this mysterious chromatic ribbon.

Sunlight, we are told, is composed of the following parts:

54	Red
140	Orange-red
80	Orange
114	Orange-yellow
54	Yellow
206	Greenish-yellow
121	Yellowish-green
134	Green and Blue-green
32	Cyan-blue
40	Cyan
20	Ultra-marine and blue-violet
5	Violet
1000	

Condensing the intermediates with the principals we have:

Red colors	194
Golden colors	454
Green colors	255
Blue colors	97
	1000

We have an instinctive tendency to compare the color band

or scale with the musical scale; but when we do so we are landed in a maze of difficulties. We realize in sound a higher and lower, a logical connection, order and uniformity of intermediate steps. We are, therefore, bewildered to find, as we do, that there is nothing compared to this in color. There is no up or down, high or low; there is no octave, not even a completed circle; the intensity of sensation does not follow wave-length or even luminous intensity. The maximum of luminosity is in yellow between D and E, but green, a comparatively dark and cold color to the imagination, is not vastly less luminous, while it is far more so than red, which, of all colors, stands out most vividly to the mind's eye. We are perplexed to find no law or reason governing the position, extent, or psychological characteristics of colors.

We think we shall find that much of our amazement and inability to see law and reason in the phenomena arises:

1. From our inattention to the history of the physical stimuli of the eye, to the relative quantities and persistencies of the great classes into which ether waves may be divided, according to the natural objects from which they have, in all past time, been reflected into the eye; and,

2. From our inattention to the psychological history of vision, the psychical origin of color, and the influence of the mind and feelings upon color phenomena and perception.

History, then, is our hunting-ground, evolution our falcon, and the quarry we seek is answers to these questions:

1. The reason why certain colors are called primary or elementary?

2. Why the relative amounts of the primary colors vary as they do in the (normal) spectrum?

3. The explanation of the differences in the objective or luminous intensities of colors?

4. The reason of the differences in their subjective intensities and qualities?

We wish the reader to suppose himself never to have seen or heard of a spectrum, or a theory of color-perception; we know he is a cultivated nineteenth century gentleman, well acquainted with history, especially of primitive man and religions, and well

versed in Darwinian principles. We can assuredly congratulate him, both upon his ignorance and upon his knowledge! If we ask him what great color-classes of visible objects have most occupied man's eye and mind in all past history, we are certain his answer (after as much reflection, *parbleu*, as we ourselves have given it) will be something like the following:

The first in overwhelming importance is light and fire; the second, the world of vegetation; the third would be blood, as the concrete representative of war and struggle, and superstitious symbol; the fourth, the sky above with its reflection in the waters of the earth. It would be difficult to name another class, for whatever other colors nature may have presented to the eye of historic man, they must have been mixtures of these, or unimportant exceptions that have left only a small and inconsiderable organic response in the psychic mechanism.

Let us briefly emphasize and differentiate these four classes of stimuli a little more closely:

1. Light and Fire.—It has been said that stimuli of achromatic light are responded to by the infant before those of color, whence, if true, it would be rightly argued that achromatic vision preceded chromatic in the life-history of the animal kingdom. The absence of cones in many animals points to the same conclusion. Perceptions of differences of luminous intensity, as we know from the facts of color-blindness, may still give such animals much of the advantages we derive from color sensations. We allude to the matter here as of importance in showing the probable priority in time, as well as the past and present preponderance of the amount, of such sensations over those of others. With these we class the yellow and orange colors, begging the scientific reader not to start back in disgust, but to consider the following facts: The ordinary suffused daylight, even of a clear day, is slightly yellowish, and in almost all degrees of obscuration of the sun, the more refrangible rays being cut off, the indifference-point of the spectrum is sent farther down into the yellow band. Whether from a greater turbidity of the atmosphere, or increase in thickness of the several mile deep dust-shell always present over the earth, or from the morning and evening obliquity of the sun's rays, much of the *day* of

average humanity has been more yellowish than they perhaps mistrusted. This, it is probable, was more pronouncedly the case in the earlier stages of the world's life. Moreover, the rising and setting of the sun have always flooded the earth for one or two hours each day with a glory of orange or golden radiance. It is also certain that our earthly fires are of a ruddy, golden or yellowish hue, and the scholar of mythology and early religions, knows well enough the part fire has played as a representative of the unseen divine life, or as an homologue of the recurrent changes of the lights of the sky by day or by night. "Pyrolatry," says a life-long student and historian of ethnic religions, "is common to all religions." "Through the whole history of Aryan faith runs the fire symbolism of Mithra." "Jahveh was originally one of those sun-gods in whom all Semitic worship was wont to centre." Quotation from a thousand sources could be added, all of the same import. We all know the beautiful myth of Prometheus and the stolen fire. Ever since man's dawning intelligence caught a glimpse of the mystery of light, of the wonder of the strange lurid glow of the sun at eventide—nay, even back to the time when, by its aid, he cooked the flesh of the animal whose blood he had shed, the wonder of fire was daily and hourly before and in his eyes. Further reason for including the daylight, the sun-shine and the fire hues under the general term golden, comes from the symbolism of gold itself, which, in all ancient faiths, as well as in the instinctive feeling of the modern artist and poet, is the representative metal and color of the divine glory and halo. Perhaps it would not be unwise to say that gold is now the standard of all values, and held to be the loveliest of metals, because it was once the symbol of all light and the ornament of the divine image.

To this consensus of reasons might be added the comparative absence of whites in nature. Clouds are sometimes a dull or grayish white, and snows, however considerable in some countries, are certainly the world over, a small and short-lived covering of the earth's surface. Wherever white sunlight falls on land or tree or rock, it is always reduced to colors by the unequal absorption and reflection following; these colored reflections are the eyes' customary stimuli. When sunlight falls on

the sea only a small portion of the surface reflects white back to the few eyes there or thereabouts. So that as a fact white sunlight is generally reduced to yellowish tints, or other shades before it reaches the eye. Where this is not the case, the rays are too powerful, and producing unpleasant effects upon the eye, are avoided.

The closeness of the relationship between white and golden light is also shown by the ease with which spectral yellow, by increase of illumination, passes over into white, being, as it is, the nearest of all colors to the luminous intensity of that compound. Consequently a complementary color of the lower kinetic value is all that is required to quickly heighten it into the white to which it is so closely allied.

The proportion of the spectral golden rays, 454, or nearly half of the whole, represents the overwhelming part the lights of day and of fire have played in the world's history. The unity of character running through this vast space of the spectrum, testifies to the unity of the cause, and to its power both physically and mentally.

II. The Vegetable World—whose greens have taken up the next greatest portion of the spectral rays—representing one-fourth of the whole—is so plainly the origin of the green band of the spectrum that it is unnecessary to go into detail concerning it. When eyes appeared, next after the golden light of day, they would certainly fall upon some of earth's verdure, and except to the city-man, the proportion holds up to to-day. Green is philologically the growing thing, and grass or tree covers the face of the earth.

Red, occupies the next lower degree in the proportion of the spectral waves. The crimson of the fruit man ate, or of the wine he drank, the deeper orange hues of the flame-points or embers of his hearth-fire, the autumnal reds of the forest trees, or the expansive glory of an occasional scarlet sunset, would not, all combined, account for the proportion of space it occupies, and are infinitely far from explaining the intense and distinctive character of the subjective sensation of spectral red. It can only be explained by the role war and blood-shed, blood sacraments and rites, have acted in the history of the race from

man's egress out of animalism and *progress* to nineteenth century militarism. The blood is the life; and life, so far in our planet's history, has been a perpetual *bellum omnium contra omnes.* Nature herself, as our great Christian poet declares, is red with tooth and claw, while the condition of all savage races *now*, show that it was always so with our own ancestors. A curious and deeply instructive book has lately been published, *The Blood Covenant*, by Trumbull, in this only, and so far as our knowledge goes, can one learn something of the influence of the vision of blood-shedding in the early world. It is an instructive though ghastly picture, that, despite the author's sympathy and sanction, makes one shudder. Strange insights, these, into human nature, which we gain in reading of the blood-drinking, blood-bathing, blood-ransoming, blood-unions, blood-compacts and friendships, blood-sacrifices, and blood suppers, blood burials, blood cures and sprinklings, bloody hands and uplifted arms, blood transfusions, human sacrifices and cannibalisms, bloody burnt-offerings, blood-stained ark of the covenant, bloody passovers and blood atonements! And all this in times of peace! What an echo of long ages when blood shed was no mimicry! The bloody idea is certainly "nail'd wi' scriptur." This is all legend and myth; when authentic history begins, it writes of the sword and red-handed death; the record rolls on with the tired centuries depicting one monotonous tale of sanguinary strife. "War is the matter which fills all history," says a great historian. One million nine hundred and forty-eight thousand lives lost in the last twenty-five years in European battles, and twelve billions of dollars worse than wasted, is the last record, with Europe a huge camp to-day. We spare the reader further quotation and detail we had prepared.

IV. The Proportion of Spectral Blue is small in extent and weak in power; it has a character of distance and impersonality exactly corresponding to the sources whence this color has reached the eye. The sky is above, but man's eyes are seldom raised to it. At the horizon it often fades to the violet in which the spectrum likewise passes out of sight.

Rassemblons nos faits pour nous donner des idées.

1. In answer to the first query we started out to solve, cer-

tain colors are called primary or elementary, because they have been derived from these great divisions of natural objects we have reviewed. They have been the uninterrupted stimuli of the visual function, since the brain sent its retinal servant out to the body's surface to see by its aid. Some are, if we may so speak, more "elementary" than others, in the sense that some stimuli have been either more prevalent, more powerful or more vitally interesting than others. This is overwhelmingly so of red and gold. In Swinburne's Poems and Ballads, Mr. Grant Allen found the red epithets numbered 159, the gold 143, the green 86, and the blue 25. In Tennyson's Princess the same proportions were 20, 28, 5, 1; and it was so in other cases.

2. A *color* of the spectrum occupies just that amount of space, or, to put it in another way, waves of more or less extended differences of length are perceived as a single color, just as the bulk of the waves from each of these classes of objects have been most uniformly and persistently reflected into the eye during the growth of the race. Nature has acted upon the organism in these continuous ways, and the cerebral product is the spectral colors, in the proportions, and with the characteristics, we find appearing in consciousness. The largest and most persistent stimulus has been that of the gold rays—the varied shades of the diffused light of day, or the ever-present mystery of fire. These have been poured in profusion into all eyes, comprising nearly one-half of their total stimulus, while the green rays make up a fourth, the red less than a fourth, and the blue a still more limited amount.

3. It is a remarkable fact that the objective luminous power follows the same law, and is not caused as we might *a priori* suppose, by the wave-length. According to the latest measurements, by Messieurs Macé and Nikati, the following are the relative luminous powers of the wave systems corresponding to the wave-length first given, the highest power, corresponding to wave-length 569 mm. millionths being given as unity:

$$\frac{681}{0.015}\ \frac{656}{.080}\ \frac{641}{.111}\ \frac{613}{.252}\ \frac{589}{.768}\ \frac{569}{1.000}\ \frac{550}{.954}\ \frac{534}{.512}\ \frac{527}{.400}\ \frac{520}{.314}\ \frac{507}{.128}.$$

In order to reach the same result of visual acuity, as in the 569 rays, the quantity of light of red, had to be increased

sixty-six times, of green three times, of blue eighteen times, of extreme violet 5460 times.

The explanation of these figures will be found to lie in the physiology of the retina- The stronger waves do not, as we see, produce the mostpowerful effect; indeed, the luminous intensities have no relations with refrangibility, but seem to depend on facts of another order, which consist in utilizing the residue of rays left over after the absorptions of natural bodies have been satisfied. The greater the wave-length the more wholly such are absorbed, until the line of the descending curve dips pretty low down in red or orange, when the residue becomes so great that the the light-curve takes its swift rise, to fall gradually from its crest in D¼E, to the extreme end of the visible spectrum, where the dispersive forces of atmospheric refraction allow few of the more refrangible rays to pass to the eye. So the retina has learned to react, not to the most powerful, or to the finest, but to the most continuous and steady stimuli. Its response, therefore, is more perfect to the gold rays, next to the green, lastly to the red and the blue, as Macé and Nikati have found.

4. But there has been a great failure to differentiate the objective from the subjective intensity. Confounding these wholly different phases, has resulted in the *non sequitur* of Magnus and Gladstone, who think red was the first of the colors historically developed. To this we shall retnrn later. Color being a creation of the mind, and after a double transmutation of forces, it follows that its subjective character, may, in part, be independent of objective causes, or direct stimulation,—may be a complex whose elements are by no means all gained through the retina or the visual mechanism. A thousand facts prove, that of all the senses, vision is the most freed from the bonds of logical and necessary connection with the primary sources of stimulation. No fact is more strikingly characteristic of this law than these differences between the objective and subjective intensities of colors. As we have just seen, the order of the former is the highest in gold, falling then to green, red, blue; the order of the second is red, golden, green, blue; and precisely this order tallies with that of the vital and personal

connection with man's life of the four classes of natural objects we have named. The mordant acids of life's needs and passions have eaten these tones deeply, or less deeply into man's brain, according as they have in varying degrees been associated with his miseries and gratifications. Only on this principle can the vivid and powerful effect of red be explained. If private and public blood shed, if social and religious blood covenants, all of which have always been bound up with every day of humanity's advance, — if these would not have bitten into his being an intensity of response unapproached by all other chromatic stimuli, then, the laws of reaction and association taught by scientific evolutionists are empty of force and void of truth. In the language of physiological psychology, this fact might, perhaps, be expressed as the demand for more numerous connections with other cortical centers corresponding to the variety of interest the stimulus excites in them, and the power required in co-ordinating the multitudinous waves of emotion called forth.

The most valuable thing to a man, is of course, his life, symbolized forever, in fact and in covenant, in rite and in ceremony, by his blood. Next to this comes the light of day and of fire, which he has always represented to his mind, as it has been to his eye, of a golden hue, under which term may be accu. rately grouped the changing effects of the ruddy, orange, or yellowish whites, of light and fire.

Among earth's vegetation man has, of course, built his home; but there is in the subjective green a lack of power and intensity exactly corresponding to the nature of our impersonal and semi-independent relations to the verdure and growing things about us. In blue these qualities are exaggerated into the feeling of distance and coldness and elevation, derived, of course, from the far away mystery of the sea and sky.

The Intermediate Colors of the Spectrum should be considered for a moment. The fact of their existence is almost forgotten by color students. This neglect is all the more remarkable when we observe their amazing extent. While each pure "primary" color comprises from forty to eighty parts, we find the mixed intermediates stretching out to 140 between

orange and red, to 114 between orange and yellow, and to 327 between yellow and green! Strictly speaking, these are just as "primary" as the other shades we call red, or yellow, or green. The whole nomenclature is relative, a mere thing of custom. If simple spectral space occupied, or, if the proportions these intermediates bear to the whole number of rays, were decisive, the small spaces of the purer colors would serve as the unnamed delimiting lines for the other and larger stretches and quantities. The extent of these spaces shows us how differing nature's "colors" are from those of the mind, or rather, what receptacles and constructions the mind puts upon the color-intimations or hints of nature. Nature's colors are always broken and mixed; the spectrum gives us homogeneous wave-systems, sorted out of the compound, and arranged seriatim. The prism brings order out of chaos, whilst the mind still further idealizes and reconstructs for itself another world out of the spectrum, by ignoring the mixed intermediates, and emphasizing the small spaces more pleasing to it. But, keeping close to nature, we must ask concerning the significance of the extensiveness of these spaces. This can only lie in the fact that nature's colors are not saturated (from homogenous wave-systems of maximum strengths), but are always from mixed wave-systems, culminating in a higher average of those of one of the four primary colors in each of the four classes of phenomena mentioned. The ocean swell may be made up of many lesser crests and troughs, but there is always one point where the general variations reach their maximum, and this would correspond to the narrow limits of the *pure* color. But between these crests are large regions of indeterminate mixture, Between the pure hues of the deep autumn reds, and the paler yellows, and beyond the rapid instants of ruddy flames and setting suns, are the multitude of ever changing tints of brighter glows, which account for the 140 parts between spectral red and orange. In a like manner we perceive the rationale of the 114 parts between orange and yellow, whilst the protean changes and mixtures of the ever-varying light playing amongst the myriad tinted shadows of the infinite variety of vegetable forms, produces the enormous interspace represented by the

327 intermediate parts, between the yellow and the green of the spectrum.

It will be seen that our endeavor has been to institute a correspondence between luminous stimuli from the natural world, and the chromatic effects of the spectrum's analysis, upon the mind. In all text books and expositions of chromatic and prismatic phenomena, the facts are placed before the awe-struck mind of the beholder without a word more explanation than nature herself vouchsafes. "Beauty is its own excuse for being." The colors, forsooth, are produced by the varying wave-lengths; but why the order, why the quantities, why the amounts, and a thousand other whys—these have always been starting up in the mind of the cause-seeking student. His answer has been the old one given to little Peterkin, when he wanted to know "what was it all about." We indulge the hope that by some such method as we have tried to strike out in this crude fashion, the answers must be finally found. Our color sense must be the organism's response and reaction under stimulus; in a word, it must be investigated by the methods of study which evolution has taught us to use with such brilliant results, in all other departments of biology. The hand of a man, the wing of a bat, the dog's fore-foot, and the horses' fore leg, the bird's wing and the seal's paddle — these are all modifications of one structure, according to the work to be done, and in response to the peculiar stimulus; just so the cerebral products of multiform color-stimuli have left their psychical analogues in our own complex color-sense. The historical and comparative method must likewise be adopted here. For two thousand years psychology hardly advanced a step, because it only interrogated the single and then present mind. Deductive and *a priori* cloud-capping systems of metaphysics and speculation ended in Hegelian Quixotism, and "subjective camels" of strange morphology. Survival of the fittest and comparative methods put an end to all that, and it may be hoped that the same historical method will unravel chromatological problems which have, as we have seen, not been even stated so far.

To a genial and enthusiastic populariser of the evolution phil-

osophy is due the honor of the first tentative effort in this direction. Mr. Grant Allen, (*The Color-Sense*), sought to explain our color-sense through its development, at first, in insects, seek- the nectar of flowers, and also in frugivorous animals, by spying out colored fruits. The book is inherently interesting and valuable; the theory is good enough so far as it carries, but it is not to be forgotten that the flowers are the absolute creations of the eyes, and not the eyes of the flowers; it is hard to escape from the logic which demands a pre-existent color sense of some kind before flower and fruit could utilize the owners of eyes as their messengers and express-agents. Apart from this, we are, if at all, certainly *very* remote descendants of insects, and are quite far away from the birds and such frugivorous folk.[1] It remains to us a marvel of oversight, a curious instance of *idée fixe*, that the great sweep of the mighty, forces we have tried to hint at as causally operative in forming our color-sense, should have escaped the gaze of this writer, otherwise so keen of sight on the evolution trail. To have credited these two influences, which, however real and operative in their limited field, were yet trivial and comparatively of little reach, with the construction and organization of our widely complex chromatic sense is a fatal illogicality. He should have taken to heart his own noble and true saying, that, "Evolution forever impresses upon us the lesson that if we would be good philosophers, we must forget our philosophy."

We may in passing allude to the discussion concerning

THE HISTORICAL ORIGIN OF THE COLOR-SENSE.—Gladstone as a Homer-student, and on simple philological evidence, tried to show that "they who fought at Troy" were as blind to certain colors as Homer himself (supposably) was to all. Dr. Magnus, in Germany, drew the same conclusion from a wider sweeping

1 As to reasoning concerning the subjective quality, or character of the sensations of color in animals, it must for the present be pronounced out of the question. The subjective expression of the stimulus can only be compared in beings whose minds and psychological histories have been the same or similar to our own. The character of red, e. g., to the animal, as to us, must depend upon the connection of "red" things to the past history of his race.

of word-lore. The whole affair was a dismal collapse, and Allen pricks the bubble with justifiable satisfaction. It was hardly to be expected that if ants, bees and birds had such highly developed chromatic powers, even savage men should be so far behind them. Present day barbarians have essentially the same power in this respect as ourselves, though extreme delicacy of perception is, to be sure, not so highly developed, and their nomenclature would of course be very faulty or deficient, as Gladstone and Magnus might have supposed. The savages' delight in color, as shown in tattooing, and decorating his body, presupposes the ability to feel the differences in color quite as accurately as the birds, whose bright plumage he adorns himself with, and who have no words for colors either. The development of color perception lies far back of all this, and is as old as hunger, in satisfying which, and by the attacks and escapes of enemies, it quite certainly took its rise. The sobering remark of Wallace is also *a propos*, that it is the absence of color that would require accounting for; he says that the most conspicuous pigeons, whether by their color or by their crests, are all found where they have fewest enemies. There seems, indeed, to be an exuberant energy in al' organized things, which is only kept from developing variations, and ornaments, and bright colors, by the necessity they are all under of escaping pursuit or hoarding their powers. So it may at last turn out that animals are as bright and beautiful as they can be, consistent with the more important law of self-perservation.

The fact that in $\frac{99}{100}$ of all color blindness, perception of red seems to be the deficient power, would imply that it were the latest, instead of the earliest acquirement, as has been held.[1]

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1 A great support of the Hering theory lies in the bipolar nature of color-blindness, red-blindess being always, or generally associated with green-blindness. But if red be thrown out of the complex of elements making white, by some unexplained pathological condition, the resulting unity of white, the indifference-point of the spectrum, is moved forward into the green space, and the neutral indeterminate we call white, supplants the green sensation. By a musical note, continuously sounded, the ear becomes incapable of hearing that note; silence results; so, blue glasses, continually worn, destroy the possibility of perceiving blue. In this way the transparent or invisible nature of the indeterminate compound we call day-light white, is explainable, and the similar extinction of green, when red is thrown out of the compound. In total color-blindness, blue sensations are wanting from the same reason, that the indifference-point is removed to the place usually occupied by blue.

The delight of children and savages in red, and the coarse æsthetic sense. might in part, be explainable in the same way, but more accurately and perfectly by the subjective vividness and associations resulting from numberless centuries of blood-covenants and blood-shed. Red is the color of war; savages tattoo themselves with it to arouse their own blood-thirsty instincts, and to strike terror into the hearts of their enemies. That the prevalence of red pigments in nature, the ease of procuring the ochreous earths, and the relative difficulty of getting other pigment colors, would explain the savage predilection for red, is perhaps a slight coign of vantage, but it remains still an example of the triviality of the arguments to which theorizers have been driven. In continuance of the same symbolism as the bedaubed Indian gives to red, it has continued till to-day as the color *par excellence* of military uniforms. The delight in it by the crude æsthetic sense flows naturally from the ages of history when bravery and courage were in man almost the only, certainly the highest of all qualities.

The Æsthetic Symbolism of Color.—In accordance with our conceptions of the origins of our color-sense, there should be a natural association and symbolism of the different colors with the great classes of our emotional states. If man himself is the concrete result of cycles of permanent reaction between organism and environment, then his visual sense must find its ultimate explanations in the same process, and, like them, look forward to extension and perfection, on the same lines as its development has followed. Now, upon looking within, it is not a little startling to find the great divisions of our psychical nature corresponding with the great associations and divisions of our color-sense. It would be still more striking, if we were not now partially aware of the role color has played in history and in the development of the mind. All objective existences are perhaps more vividly represented to the imagination as colored things, than in any other way, and their associations with the woes and joys of life point to no fanciful symbolism, but one which is quite as real and vital as the emotions whence he draws his mental life. Classifying the directions and methods of mental activities, we find them to fall naturally into four classes:—

1. Those of the Passions, — the emotions pertaining characteristically to the sensual life;
2. Those of the Intellect or Reason;
3. Those of Utility and Labor;
4. Those of his Spiritual, Moral and Religious Nature.

These we find to correspond in an exact and specifically real sense with the four analogues of the chief colors previously set forth. Blood is the life, — the nearest, most precious, and vivid of all things or thoughts. Golden light is next in its necessity and nearness to our daily life; of green we are somewhat more independent, while blue is far away and beyond the reach of our earthly cares and wants.

The symbolisms of red are, therefore, perforce, those of the two great factors of history, War and Love.[1] That only the homologues of the rigorous challenge of red.

In the same definite way the symbols of golden light apply as fittingly and restrictedly to the light of reason and intellect which, flowing over and through all the world's ways, alone promises that clearness of vision by which we can walk in the labyrinthine ways of crowding passions, necessities and duties.

But it is in the world of earth's verdure that man's daily life is cast, and among which he builds his home. This, with its cultivation and shade, its fruitage and various sustenance gives him occupation and rest, food and contentment. So in our psychological analogies, green may stand as the every-day color of general back-ground, of labor, of use, of home-life, peace and rest.

1 Hargraves Jennings and his Rosicrucians would find a not unjustifiable connection between love and a "blood-covenant," which at recurrent lunations has emphasized the underlying unity of these two great passions, before the phallic worship at the roots of all primitive faiths had passed into multitudinous rite and symbol.

brave *had* the fair, is much truer than that only they *deserved* the fair. The passions, therefore, which stir the blood and heart of men to action, the emotions of honor, vengeance, valor, love, friendship, protection,[2] etc., etc., — these are the fitting

2 Reference to Trumbull's book must again be made for clearer explication of the words.

Lastly, how appositely blue represents the spiritual life of duty and religion! Blue, derived from the changeless deeps of the arching sky, — overcast, perhaps, for a time, by the passing clouds or mists of mundane change and chance, but always still there, the same forever, the same by day or by night, distant and yet constantly watching over us, impersonal, yet ever in touch with our strongest passions and humblest utilities.

THE AMERICAN OPHTHALMOLOGICAL SOCIETY.

The twenty-second annual meeting of the society was held at the Pequot House, New London, Conn., July 21 and 22, 1886.

First Day. — Morning Session.

The meeting was called to order by the president Dr. William F. Norris, of Philadelphia.

A business committee consisting of Drs. E. Greuning and S. D. Risley, was appointed.

A communication with reference to the organization of a Congress of American Physicians and Surgeons, was read and referred to a committee, with instructions to report at the present session.

Dr. Peters, of New York, Dr. Hubbel, of Buffalo, Dr. E. Friedenburg, of New York, and Dr. Cutter, of New York, were invited to take part in the discussions of the society.

Dr. H. Knapp, of New York, read a paper on

Pyogenic Micro-Organisms, with Demonstrations and Experiments.

Dr. Knapp made some general remarks with reference to the dependence of suppuration on certain kinds of micro-organisms. the pyogenic bacteria, of which pure cultures had been obtained during the past two years. He exhibited these bacteria in numerous test-tube specimens on agar-agar and also under the microscope. He also exhibited slides of different tissues of the eyes that had been infected with these germs. He showed two rabbits which he had operated on for cataract the day before, in the presence of members of the society. Extraction had been made on the left eyes with clean instruments, and the right eyes with instruments contaminated with staphylococcus pyogenus aureus. The left eyes were free from secretion. The wound of one eye in a doubtful, the other in a good con-

dition, whereas the right eyes discharged matter profusely, and were in a state of intense destructive inflammation. He then operated on two other rabbits in the same way. The four rabbits were examined the next day. The right eyes in all were suppurating ; the wounds of the left eyes in three of the rabbits were in good condition. In one of the first two rabbits, it was suppurating. This eye had become infected from the right eye of the other rabbit. They had been kept together in the same box, and the operator had found them with their heads in contact.

These demonstrations were made to draw the attention of the members to this new and important field of inquiry, and the speaker stated that he would be happy to furnish cultures of these organisms to any one who intended to make investigations in this department.

In reply to a questien as to the best method of cleaning instruments, Dr. Knapp said that in the institutions in Europe, the instruments are placed in an antiseptic solution. This, however, has the disadvantage of dulling the edge of cutting instruments. His experience has shown him that the simple washing with water in the case of smooth instruments, followed by friction with a clean towel, renders them bacteriologically clean. Where an instrument has a groove, or is at all rough, it is much more difficult to clean. Instruments like forceps may be put in the antiseptic solution. It must be remembered that in the majority of operations, a certain quantity of infecting material is required to produce any effect. Where there is a free escape of liquid from the wound, the material is washed off, but where there is a sucking-in process, the danger is much greater.

Dr. B. E. Fryer, of Kansas City, called attention to hydronapthol, which has lately come into use, which would probably not interfere with the edge of cutting instruments. It has, however, not been sufficiently long under observation to enable us to say whether it will completely sterilize instruments. It had also occurred to him that chloroform would probably perfectly sterilize instruments.

Dr. Hubbel, of Buffalo, asked Dr. Knapp, if there are not

certain conditions of the eye which would favor infection of the wound after operation. He had recently operated on a case of cataract in a man sixty years of age, where there had been a long standing purulent inflammation of both conjunctivæ. He performed an iridectomy, following it in two weeks, with extraction. Both operations were entirely successful and without accident, notwithstanding the fact that there was a constant purulent discharge. The only antiseptic used was a solution of boracic acid.

Dr. H. Knapp, in reply, said that he thought that a lachrymal discharge with a certain amount of conjunctivitis furnishes a favorable soil for the growth of bacteria. In operating in such cases, the discharge should be complely removed. As he had already, said a certain quantity of the pathogenic bacteria are required to produce infection. He had pricked the cornea to one-third or two thirds of its depth, and covered the wound with an emulsion of the bacteria, yet in only one out of every four or five did abscess develop.

Dr. J. A. Andrews, of New York, said that he had frequently pricked the cornea and applied the staphylococcus pyogenus aureus and had repeatedly seen recovery follow without suppuration or inflammation. Mere contact of the microbe with the wound is not always sufficient to produce suppuration, especially in the case of the cornea where the discharge is liable to be washed off. Where the material has been introduced into the wound and kept there for a short time, he had never seen a failure.

In the cleaning of instruments he uses what he terms "aseptic fluid." He procures clean water, and boils it for some time. The principal value of antiseptic solutions in hospitals is, he thought, the fact that they furnish something you are sure is clean. The water is not always clean. He did not mean to be understood as saying that he used boiling water. He boiled the water simply to render it aseptic.

An Analysis of One Hundred Cases of Exudative Retinitis Occurring in the Course of Bright's Disease.

BY DR. C. S. BULL, OF NEW YORK.

Only such cases were included in the report as had been exam-

ined by the writer, and had been followed to their termination. All cases due to scarlatina or pregnancy were excluded. Out of five hundred cases examined only one hundred and three fulfilled these conditions. The ophthalmoscopic examinations were made by the author, and the urine was always examined. In fifty-four of the cases, both eyes were affected when the patient came under observation, and in ninety-three per cent both eyes were ultimatey involved. Hæmorrhages occurred in sixty-nine cases. In thirty-four cases, there were no hæmorrhages. The hæmorrhages were intimately connected with disease of the blood vessels. Only one instance of color affection was observed.

The prognosis with reference to the duration of life is very unfavorable. The one hundred and thirteen cases reported were collected during a period of thirteen years. Of this number eighty-six have died; fifty-seven during the first year and twelve during the second year. Of the seventeen still living, fourteen were seen in the last six months. One of these cases, however, was seen for the first time seven years ago.

A rather unusual complication was seen in four of the cases, that was the presence of sugar as well as albumen in the urine. The amount of sugar was variable.

DISCUSSION.

Dr. E. Greuning, of New York, said that he had collected over one hundred cases of this affection and he found that none of his cases had lived over two years after the diagnosis of retinitis albuminurica had been made. In this class of cases he included only those in which the typical stellate changes were seen in the maculæ of both eyes. He had lately seen this appearance in the macula of one eye, in a patient who presents no evidence of Bright's disease. This is the first time that he had seen this change without signs of renal disease.

Dr. B. E. Fryer, of Kansas City, remarked that in these cases albumen is occasionally absent from the urine for a short time. In two such cases he had found that albuminosis was present during the time that albumen was wanting.

Dr. David Webster, of New York, said that he was satisfied that in rare instances these patients do recover their general health, and may live indefinitely. Some years ago he exam-

ined the eyes of a clergyman and found the typical appearances of retinitis Brightii. This patient had been examined fifteen years previously by a competent observer, who found the same condition, and also found albumen and casts in the urine. He had the urine examined and found a slight trace of albumen.

Dr. O. F. Wadsworth, of Bostou, said that where the retinitis albuminurica comes on during or immediately after pregnancy he had seen the stellate spots in the maculæ entirely disappear. He had also seen typical stellate deposits in cerebral tumor, and what was supposed to be meningitis, but in which there was no albuminuria.

Dr. E. Greuning, of New York, remarked that the cases of retinitis Brightii which we see in our offices, differ very materially from those which we see in hospitals. The patients who consult the oculist are usually those with the small contracted kidney, while the patients with the large white kidney find their way to the hospital.

Dr. C. S. Bull, of New York, desired simply to repeat what he said in his paper, that he had excluded all cases where the albuminuric retinitis was due to scarlet fever or to pregnancy. He did not hold that the so-called stellate exudation in the region of the macula is typical of Bright's disease. He had seen it in intra-cranial tumor, and in cases supposed to be meningitis. Retinal exudation, other than stellate, he had seen not infrequently in cases of large white kidney.

Thrombosis and Peri-Vasculitis of the Retinal Vessels.

BY DR. GEORGE C. HARLAN, OF PHILADELPHIA.

Mrs, F. B., age 33 years, came under observation June 5, 1886. Her father aud a younger sister had died of Bright's disease, the mother of paralysis. During the past two years, she had had considerable headache. She had a miscarriage in July, 1885, from which her recovery was delayed. She had a second miscarriage without special trouble, in January, 1886. There was no trouble with the eyes until May 7, when she noticed dimness of vision in the left eye. This increased during the day

and the following morning there was only light perception in this eye. She was examined two weeks later by a surgeon who pronounced the condition one of embolism. There was no suspicion of specific disease, There was no uterine trouble, and the heart sounds were normal. The urine had a specific gravity of 1009, contained some albumen, but no true casts were found. Examination of the eyes showed no light-perception in the left eye. The media were clear there were hæmorrhages scattered through the retina. Some were striated, extending in long streaks along the vessels. There were three groups of white spots at the macula. With one exception, all the vessels of the retina were converted into white bands. The exception was a small artery having an independent origin. The vessels were of nearly normal size. Five or six weeks later, the hæmorrhages had been absorbed, but there were no other changes. In the right eye there were several small hæmorrhages and two filmy white patches; these subsequently disappeared. In July she had a slight attack of paralysis on the left side, and examination of the urine showed some albumen and hyaline tube casts. The rapid on-set and the occurrence of blindness within a few hours, seemed to exclude the possibility of disease of the vessels. Embolism would not account for the condition. The speaker suggested that the partial blindness for the first few hours was due to hæmorrhage, and that the complete blindness coming on later was due to thrombosis. Thrombosis of a whole series of vessels is, however, rare. Another probable explanation is that there had been for some time, disease progressing in the outer walls of the vessels, without giving rise to sufficient disturbance of vision to attract attention.

By way of comparison a second case was described in which the affection seemed to be a perivasculitis. It was that of a negro woman who had been partially blind for a long time. The right eye was the seat of a dense cataract. In the left eye $V = \frac{20}{C}$. The lens was hazy and the disk pale. Extending upward there was a large artery converted into a chalky band; two smaller arteries exhibited the same condition in places.

A New Test Type.

BY DR. WM. S. DENNETT, OF NEW YORK.

The speaker called attention to the fact that although for twenty-five years, the schools of the civilized world had been under the observation of oculists, who all agree that great good would be done by periodical examination of the eyes of scholars, and although such examinations were very simple, the internal inertia of existing institutions had always prevented any continued action on the part of the schools. Among the laity there is absolutely no knowledge of what normal eyes should be expected to see. A card was presented which was designed for the use of educational institutions. It contained one set of letters and a statement of the exact distance at which these letters should be seen. The desire was expressed that this or some similar card should be placed on the wall of every school room, in a conspicuous place, so that it should become of necessity a familiar object and a standard of measurement that would be remembered through life.

The Possible Retardation of Retintiis Pigmentosa in the Young.

BY DR. HASKET DERBY, OF BOSTON.

This affection is, as a rule, considered incurable, leading gradually to complete blindness. In America this disease is exceedingly in-frequent, the author having seen it but twenty-seven times in thirteen thousand eye cases. In 1881 a boy three years of age, was brought to him from Virginia. It was observed that toward night his vision diminished. There was no history of blindness in the family. Five years later he came again accompanied by his sister, seven years of age. Both children were night-blind and presented the evidences of retinitis pigmentosa. Under the use of the constant current there was improvement. A similar case of improvement under the use of the constant current, under the care of Dr. Standish, was reported.

The object of the paper was to invite discussion as to the use or non-use of such eyes for educational purposes, and as to the

possibility of adopting measures for delaying the process of the organic change.

A third case, that of G. W., aged fourteen, was described. He presented the typical appearances of retinitis pigmentosa. Non-use of the eyes and the application of the constant current was recommended. He was subsequently advised, by others, to use the eyes freely. In five years vision diminished from three-tenths to one-tenth. This rapid progress of the disease, it was thought, might have been aided by the use to which the eyes had been subjected.

Discussion.

Dr. William S. Little, of Philadelphia, had observed in one case of retinitis pigmentosa occurring in a deaf mute decided improvement in vision under the use of the Faradaic current. The improvement continued for two years without change. He then went West and seven years after the applications he was doing well, but could not see quite as well at night as before.

In two cases coming to the Jefferson College clinic, the pigmentation had proceeded so far that the vitreous was also black. This he had never seen before.

Dr. L. Webster Fox, of Philadelphia, said that he had had the opportunity of treating a number of cases successfully. He had found that it was the negative pole that produces the good results. He also stated that if there was no enlargement of the field, after three applications, improvement was not to be expected. In all the cases in which improvement took place the blood vessels seemed to increase in calibre, and the night blindness correspondingly diminished.

Dr. George C. Harlan, of Philadelphia, remarked that he had recently seen two well marked cases of this affection, one in a boy of seventeen years of age and the other in his sister a few years older. His faith in any form of treatment being weak, he recommended that the best use be made of the eyes while sight remained. From the cases which he had seen, he thought that there is likely to be a culmination of the disease about puberty.

Dr. George Strawbridge, of Philadelphia, stated that he had

tried the use of electricity in this affection thoroughly, some ten years ago. He did not obtain benefit in a single instance. He placed more reliance upon the occasional use of alteratives such as bichloride of mercury and iodide of potassium, looking upon these cases as of syphilitic origin, probably dating back a long period.

Dr. Samuel Theobald, of Baltimore, had had no experience with the use of electricity in retinitis pigmentosa. He had, however, seen temporary improvement from the continued use of phosphate of iron, quinia, and strychnia. One of these cases was seen when eight years of age, some ten years ago. He retains sufficient vision to enable him to perform his duties as a traveling salesman. There was a history of a similar trouble in other members of the family.

Dr. S. G. Risley, of Philadelphia, said that it had seemed to him that with the hypodermic use of strychnia he had secured improvement in the general sharpness of vision. He had frequently seen improvement follow the use of this drug, but it had never been permanent. As regards the age at which this affliction may develope, he had seen it in two children of the same family occur under five years of age.

He mentioned another case, that of a young man who consulted him with retinitis pigmentosa, with marked contraction of the field and asthenopia, principally due to hypermetropic astigmatism. To relieve the asthenopia a weak solution of eserine was ordered. Under its use vision decidedly improved. He had used this solution more or less for the past two years, and finds that when he is without it he is distinctly more uncomfortable.

Dr. O. F. Wadsworth, of Boston, referred to one case which, in connection with those reported, showed the variable course which the disease may pursue when left to itself. A young man, twenty-four years of age, a divinity student, was seen in 1873, presenting the typical appearance of retinitis pigmentosa. He had well marked night-blindness. He continued his work, and eight years later, vision was about the same, but the visual field seemed to have decreased to a slight extent.

The Equivalence of Cylindrical and Sphero-Cylindrical Lenses.

BY DR. EDWARD JACKSON, of Philadelphia.

The paper was intended to demonstrate the laws of such equivalence, showing that equal crossed cylindrical lenses are optically equivalent to a spherical lens of the same refractive power. Crossed cylinders of unequal refractive power may be regarded as crossed cylinders of equal refractive power combined with a third cylindrical lens, or as their equivalent, a spherical combined with a cylindrical lens. It was proven that any two cylindrical lenses with their axes placed obliquely, the one to the other, might be represented by crossed cylinders, that is, cylinders with their axes perpendicular to one another, or by their equivalent in the shape of a sphero-cylindrical lens. Hence that any number of cylindrical lenses with their axes placed in different directions, are optically equivalent to a single sphero-cylindrical lens. To determine the sphero-cylindrical equivalent of any two cylindrical lenses, construct a parallelogram, two sides of which are proportional to the refractive power of the given lenses, the angle included by these axes being double the angle made by their axes. Then the diagonal which cuts this included angle will be proportional to the cylindrical portion of the desired equivalent, and to get the spherical portion, it is only necessary to subtract one half of this cylindrical equivalent from half the sum of the cylinders given.

Discussion.

Dr. William S. Little, Philadelphia, said with reference to the practical side of the question, that in about one half of his cases of mixed astigmatism, the patients have preferred crossed cylinders to their equivalent sphero-cylinder. In using a sphero-cylinder, it is essential that it be accurately centered.

The committee to whom was referred the consideration of the proposition with reference to the organization of a Congress of American Physicians and Surgeons, reported the following resolutions and recommended their adoption :

Resolved, that a committee of five be appointed by this society and be authorized to confer with committees from other

medical societies, with regard to the organization of a convention or congress of such societies, and report at the next meeting of this society.

Resolved, That it is the sense of this society that its welfare would be put in peril by any alliance or cooperation which would interfere with its autonomy or independent meeting.

These resolutions were adopted, and the following committee subsequently appointed:

O. F. Wadsworth, Boston; C. S. Bull, New York; George C. Harlan, Philadelphia; Samuel Theobald, Baltimore; and B. E. Fryer, Kansas City.

[TO BE CONTINUED.]

ONE HUNDRED AND TWENTY CASES OF ANÆMIC AND ATROPHIC CONDITION OF THE OPTIC AND RETINA.—By Adolf Alt, M. D.

(Table No. 1, Continued from Page 215).

No.	*Name and Age.*	*Cause.*	*Pupils.*	*Ophthalmoscopic Appearance.*	*Color perception.*	*Visual field*	*Visual acuity.*	*Treatment.*	*Time of observation.*	*Result.*	*One Eye.*	*Both Eyes*	*Remarks.*
71	A. B. 36.	Tobacco.		Discs pale; arteries threadlike.		Central scotoma both.	$^{20}/_{50}$ Both.	Abstinence strychnia intern.	2 months.	$^{20}/_{20}$ Both.		1	Never drank any alcoholic drink.
72	Miss B.D. 12.	Congenital.		Discs white; bloodvessels very small.			$^{20}/_{200}$ Both					1	Microphthalmus; divergent strabismus; nystagmus.
73	C. D. 17.	Congenital.		Pale discs.			$^{20}/_{200}$ Both.					1	Brother of former; M. 1-8.
74	Dr. H. G. 43.	Tobacco & tabes dorsalis.	Myosis. Both.	Whitish discs; arteries small.	Red-green-blind.	Concentrically limited, both; central scotoma both.	$^{8}/_{200}$ Both.	Abstin. arg nitr.; electricity; Thermo-cautery to spine; cold douche on spine.	Off and on.	Stationary.		1	No tendon reflex; had crises gastriques; sense of balance disturbed; loss of memory; spinal symptoms very greatly improved by treatment.
75	Mrs. D, 35	General anæmia.		Pale discs; small bloodvessels.			R. $^{20}/_{40}$ L. $^{20}/_{30}$	Strychnia and ferrum inter.	1 year.	$^{20}/_{20}$ with glasses.		1	Myopic astigmatism.

76	P. A. H. 29.	Tobacco; onanism; general debility.		Whitish discs.		Concentrically limited and central scotoma.	R. $^{20}/_{100}$ L. $^{20}/_{70}$	Abstinence; strychnia subcut. cold sitz baths; cold douche to spine.	2 months.	R. $^{20}/_{50}$ L. $^{20}/_{20}$		1	Emission of semen at the slightest provocation, even during work. Watchmaker.
77	D. H. B. 36.	Retinitis pigmentosa.	Mydriasis	White discs; perivasculitis.		Concentrically limited.	R. $^{18}/_{200}$ L. $^{20}/_{200}$					1	Hemeralopia.
78	Mrs. A. P. 27.	General anæmia.		Whitish discs; blood vessels small.			$^{20}/_{50}$ Both.	Strychn. intern.	Seen once only.			1	H. 1-7.
79	H. H. 48.	Alcohol and tobacco.		Pale discs.		Central scotomata.	$^{20}/_{30}$ Both.	Abstinence; strychnia intern. advised.	Seen once only.			1	Saloon-keeper; refuses to abstain.
80	M. S. 54.	Alcohol and tobacco and syphilis		White discs; bloodvessels very thin.	Red-green-blind.		R. $^{12}/_{200}$ L. $^{4}/_{200}$	Abstinence sublimate.	Seen once only.			1	Teamster.
81	R. F. 41.	Alcohol and tobacco.		Discs whitish; arteries small.		Central scotoma.	R. $^{20}/_{200}$ L. $^{20}/_{50}$	Abstinence; strychnia sub cut.; later ferrum and potass. iodid.	2 months.	R. $^{20}/_{70}$ L. $^{20}/_{40}$		1	Saloon-keeper.

TABLE NO. 1. *Continued.*

No.	*Name and Age.*	*Cause.*	*Pupils.*	*Ophthalmoscopic appearance.*	*Color perception.*	*Visual field.*	*Visual acuity.*	*Treatment.*	*Time of observation.*	*Result.*	*One Eye.*	*Both Eyes*	*Remarks.*
82	P. A. H. 26.	Alcohol and tobacco.		R. disc white.	R. impaired.	R. small central scotoma.	R. $^{20}/_{50}$	Abstinence; strychnia intern.	Seen once only.		1		Whisky dealer; L. anterior phthisis.
83	T. B. 14.	Central lesion; (cerebro-spinal meningitis).	R. Mydriasis.	White discs, especially R.; arteries small.			R. $^{2}/_{200}$ L. $^{20}/_{70}$		Seen in consultation.			1	Had cerebro-spinal meningitis 6 years previously; said to have been blind altogether.
84	T. M. 24.	Alcohol and tobacco.		Very pale discs especially inner halves.		Central scotoma.	$^{20}/_{50}$? Both.	Abstinence strychnia intern. brom. pot. and iod. pot.	3 months.	$^{20}/_{20}$		1	Saloon-keeper.
85	H. S. 51.	Injury.		L. disc almost white; bloodvessels small.		Concentrically limited, L.	R. $^{20}/_{30}$ L. $^{20}/_{100}$	Strychnia intern.	Seen in consultation.		1		Fell from a high wagon on his left side; was insensible for some time, and bled from left nostril for several days.
86	L. R. 15.	Scrophulosis.		R. whitish disc; small bloodvessels. L. almost normal.		Limited downwards and inwards.	R. $^{20}/_{100}$ L. $^{20}/_{50}$	Strychnia intern. pot. iod.	8 months.	R. $^{20}/_{50}$ L. $^{20}/_{30}$		1	About three months previously noticed suddenly that he could not see at all with R; was then treated with the constant cur-

													rent and improved to 20-100, which remained stationary; stricture of L. lachrymal duct.
87	H. E. 24.	Syphilis.		Pale discs.			$^{20}/_{30}$? Both.	Sublimate.	Seen only once.			1	
88	B. F. 49.	Unknown		White disc in R.			R. $^{4}/_{200}$		Seen in consultation.				Got blind 10 years previously.
89	B. S. 77.	Old age.	Myosis.	White discs.	Blue-yellow blind.		$^{12}/_{200}$ Both.	Strychnia intern.; stimulants.	Seen in consultation.	Increasing failure.		1	
90	Mrs. F. B. 46.	Syphilis.		R. white disc; blood-vessels small; L. neuritis optica.		Constricted to point of fixation R.	R. $^{10}/_{200}$	Strychn. subcut.; ung. ciner. pilocarp. mur. subcut.; Hydrarg. tannicum.	3 months.	unchanged.		1	R. operated upon for glaucoma simplex four years previously; no excavation; macula corneæ both; Ah. both.
91	H. H. J. 34.	Alcohol and tobacco.		Pale discs.		Central scotomata.	R. $^{20}/_{200}$ L. $^{12}/_{200}$	Abstinence advised.			1		Refuses to abstain.

TABLE No. 1 *Continued.*

No.	*Name and Age.*	*Cause.*	*Pupils.*	*Ophthalmoscopic appearance.*	*Color perception.*	*Visual field.*	*Visual acuity.*	*Treatment.*	*Time of observation.*	*Result.*	*One Eye.*	*Both Eyes*	*Remarks.*
92	J. W T. 34.	Alcohol.		Discs very pale; arteries threadlike.		Central scotomata.	20/30 ? Both.	Abstinence advised.				1	Refuses to abstain; never smoked.
93	A. M. 48.	Central lesion; (tabes dorsalis)	Unequal.	Pale discs and thin arteries.		Concentrically limited.	R. 20/70 L. 20/100		Seen in consultation.			1	Died soon after.
94	M. K. 46.	Alcohol and tobacco.	L. sluggish.	Pale discs; arteries threadlike.		Central scotomata.	R. 18/200 L. 20/200	Strychnia sub cut.; hydrarg. tannic.; cold douche; pot. brom. abstinence.	2 months.	R. 20/70 L. 20/70?		1	In the liquor business.
95	F. R. F. 44.	Probably central lesion.		Discs pale; arteries thin.			20/40 Both.		Seen in consultation.			1	
96	S. K. 23.	Central lesion (myelitis spinalis).	R. Mydriasis.	White discs, especially R.		Concentrically limited, both.	R. 10/200 L. 15/200		Seen in consultation.			1	Fell from railway car; injury to spine; incessant headache.

97	C. K. 45.	Alcohol and tobacco.		Arteries very thin discs pale.			$^{20}/_{200}$ Both.	Abstinence advised.	Seen once only.	——			1	Refuses to abstain.
98	E. C. 16.	Doubtful.		Outlines of disc L. hazy; arteries small; veins thinner than in R.		Concentrically limited.	L. $^{20}/_{50}$	Pot. iodid.	6 weeks.	L. $^{20}/_{20}$	1			
99	F. Y. 47.	Pressure from tumor of lachrymal gland; L.		L. disc white.			$\frac{1}{\infty}$	Removal of tumor and eyeball.	8 months.	Death.	1			Spindle cell sarcoma of lachrymal gland; general sarcomatosis.
100	J. G. 62.	Tobacco.		L. disc perfectly white; arteries hardly visible. R. disc pale; bloodvessels threadlike.		Restricted in- and downw'ds	R. $^{20}/_{100}$ L=0	Strychnia subcut.	Seen once only.				1	Never used alcohol.
101	Miss J. F. 25.	Neuritis optica; probably intacranial tumor.	Mydriasis both.	R. disc pale; outlines indistinct; newly formed bloodvessels. L. disc white; arteries small.			=0 Both.		Seen in consultation.				1	Continued localized headaches and attacks of dizziness.

TABLE No. 1. *Continued.*

No.	*Name and Age.*	*Cause.*	*Pupils.*	*Ophthalmoscopic appearance.*	*Color perception.*	*Visual field.*	*Visual acuity.*	*Treatment.*	*Time of Observation.*	*Result.*	*One Eye.*	*Both Eyes.*	*Remarks.*
102	W. S. 36.	Cold ?	L. Mydriasis.	L. atrophic choroiditis; white disc, small bloodvessels; R. pale disc.			R. $^{20}/_{40}$ L. $^{10}/_{200}$	Sublimate.	Seen once only.			1	Fell into river during December; was rescued after several hours only and dates eye affection from that time.
103	J. S. 15.	Scarlet fever; uræmia; optic neuritis.	Medium wide; inactive.	Discs pale; bloodvessels thin.		Central scotomata.	R. $^{20}/_{100}$ L. $^{20}/_{70}$	Strychnia subcut.	5 weeks.	$^{20}/_{20}$ Both.		1	
104	C. C. S. 35.	Alcohol and tobacco.		Discs pale; arteries small.		Central scotoma, R.	R. $^{20}/_{50}$ L. $^{6}/_{200}$	Strychnia subcut.	6 weeks.	R. $^{20}/_{20}$ L. $^{16}/_{200}$		1	Blacksmith.
105	J. K. 43.	Alcohol and tobacco.	R Mydriasis.	Whitish discs; arteries small		Concentrically restricted, both; central scotomata.	$^{18}/_{200}$ Both.	Strychnia subcut.; pot. brom.	3 weeks.	$^{20}/_{70}$ Both.		1	
106	F. W. W. 58.	Tobacco.	Myosis.	Whitish discs; bloodvessels small.	Red-green blind.	Central scotomata.	$^{16}/_{200}$ Both.	Strychnia subcutan.	8 months.	$^{20}/_{30}$ Both.		1	Never used alcohol.
107	Ph. B. 53.	Alcohol		Pale discs; arte-			R. $^{20}/_{50}$	Strychnia	3 months.	$^{20}/_{30}$		1	Married again three

		and tobacco; excessive sexual intercourse.		ries small.			L. $^{20}/_{70}$	intern. abstinence.		Both			weeks ago; noticed failure of sight since then; liquor-dealer.
108	K. C. 44.	Alcohol and tobacco.		Discs reddish; bloodvessels very thin.		Central scotomata.	$^{20}/_{30}$? Both.	Strychnia subcut.	10 days.	$^{20}/_{20}$ Easily.		1	After inj. of strychn. subnitr., gr. 1-14; sees 20-20.
109	Miss M. C. 59.	Unknown		Discs pale; arteries small.			R. $^{20}/_{70}$ L. $^{20}/_{70}$?	Strychnia advised.	Seen in consultation.			1	H. 1-40.
110	J. S. W. 50.	Alcohol and tobacco (p'rh'ps central)	Myosis.	Discs pale.	Green-blind.		$^{20}/_{100}$? Both.	Strychnia advised.	Seen once only.			1	After injection of strychn. subnitr. gr. 1-10; sees 20-50. No patellar reflex.
111	E. P. 13.	Central lesion (cerebro-spinal meningitis.)	R Mydriasis.	Discs white; R. bloodvessels almost invisible; L. bloadvessels threadlike.	Green-blind.	L. contracted almost to point of fixation	R=0 L. $^{7}/_{200}$		Seen in consultation.			1	Had three distinct attacks of cerebro-spinal meningitis.
112	W. A G. 34.	Syphilis.		Discs reddish; arteries and veins verysmall.			$^{20}/_{50}$? Both.	Potass. iod.; Strychnia subcut. advised.	Seen in consultation.			1	Had been under anti-syphilitic treatment for two years.

TABLE No. 1. *Continued.*

	Name and Age.	*Cause.*	*Pupils.*	*Ophthalmoscopic appearance.*	*Color perception.*	*Visual field.*	*Visual acuity.*	*Treatment.*	*Time of observation.*	*Result.*	*One Eye.*	*Both Eyes.*	*Remarks.*
113	J. P. L. 12.	Congenital.		Post. scleral; staphyloma both; discs white; L. choroidal atrophy.			R. 14/200 L. 12/200		Seen once			1	M. 1-12.
114	Mrs. Th. P. 49.	Unknown		Discs pale; arteries thin; post. staphyloma.			R. 20/50 L. 20/70	Strychnia intern.	2 weeks.	20/30 Both.		1	M. 1-18.
115	Mrs. A. S. 85.	Old age.		Discs white; bloodvessels hardly visible.			R. 20/70 ? L=0	Strychnia intern and stimul'nts advised.	Seen in consultation.	Increasing failure.		1	
116	W. H. 48.	Alcohol and tobacco.		Discs whitish; bloodvessels thin.	Red-green blind.	Central scotomata.	R. 20/40 L. 20/100	Strychnia subcut.	3 weeks.	R. 20/20 ? L. 20/30?		1	After injection of strychnia subnitr. gr. 1-10; vision rose to 20-40?
117	Mrs. K.R. 71.	Old age.		Discs white; bloodvessels thin.			R. 16/200 L. 20/200	Strychnia and stimulants advised.	Seen once only.			1	Strychnia subcut.; gr. 1-20 had no effect.

118	Th. S. 58.	Tobacco.		Discs pale, especially in outer halves; arteries thin.	Red-green blind.	Central scotomata.	R. $^{8}/_{200}$ L. $^{4}/_{200}$ Excentric fixation.	Strychnia subcut.; pot. iod.; sublimat.	4 months.	$^{20}/_{100}$ Both.		1	After injection of gr. 1-10 strychnia subnitr. vision rose to R. 18-200 and L. 10-200; dyspepsia.
119	F. W. S. 57.	Alcohol and tobacco.		Discs whitish; bloodvessels threadlike.			R. $^{20}/_{200}$ L. $^{14}/_{200}$	Strychnia subcut. advised and abstinence.	Seen once only.			1	Refuses to abstain; no patellar reflex.
120	Miss K. Mc. 12.	Central lesion; (probably meningitis cerebralis.	Immovable.	Discs white; bloodvessels thin.			V=0	Strychnia subcut.; constant current.	2 months.	V= $\frac{1}{\infty}$ Sees big objects as shadows.		1	Came on gradually with vomiting, fever and headache.

Of these 120 cases 95 were observed in males, and 25 in females.

The different causes to which the atrophic condition of the optic nerve was due are given in Table II.

Table II.

Alcohol and tobacco	34
Alcohol alone	3
Tobacco alone	7
Alcohol, tobacco and central lesion	1
Alcohol, tobacco and syphilis	3
Alcohol, tobacco and injury	1
Alcohol, tobacco and excessive sexual intercourse	1
Tobacco and insolation	1
Tobacco and central lesion	1
Tobacco, onanism and general debility	1
Central lesion	16
Syphilis	9
Congenital syphilis	1
Injury	6
Pressure from orbital tumor	2
Optic neuritis from unknown cause	1
Optic neuritis from uræmia in scarlet fever	1
Old age	5
Congenital	3
Insolation	1
General anæmia	3
Scrofulosis	1
Cold (?)	1
Sympathetic (?)	1
Cholera, Asiatica	1
Uterine affection	1
Cosmetics	1
Retinitis pigmentosa	1
Unknown	12
Total	120

In the following nineteen cases a central (cerebral or spinal) lesion was found to be present.

Table III.

Probably intra-cranial tumor	3
Cerebro-spinal meningitis	3
Cerebral meningitis	1
Tabes dorsalis	2
Tabes dorsalis with tobacco	1
Tabes dorsalis with alcohol and tobacco	1
Tabes dorsalis and syphilis	1
Multiple sclerosis	1
Cerebral apoplexy	1

Epilepsy	1
Softening of the brain	1
Spinal myelitis (traumatic)	1
Unknown central lesion	2
Total	19

If we add to these the cases of atrophy of the optic nerve, due to syphilis, which must probably all be considered as due to a central lesion (9), we have a total of twenty-eight cases of atrophy dependent on a distinct central lesion.

By far the largest number of cases were due to the intoxication with alcohol and tobacco, either alone or combined, or, in some cases, complicated with other affections. The following are the details of this number:

Alcohol and tobacco	34
Alcohol and tobacco with syphilis	3
Alcohol and tobacco with injury	1
Alcohol and tobacco with excessive sexual intercourse	1
Alcohol alone	3
Tobacco alone	7
Tobacco with insolation	1
Tobacco with onanism and general debility	1

This gives a total of 51 cases in which alcohol and tobacco, either alone or combined, played a role. In 44 of these cases alcohol and tobacco were the only cause to be found for the atrophic condition of the optic nerve.

As to the age of the patients, the details may be seen from Table IV.

TABLE IV.

From 1 to 10 years	2
" 10 to 20 "	13
" 20 to 30 "	13
" 30 to 40 "	25
" 40 to 50 "	32
" 50 to 60 "	25
" 60 to 70 "	4
" 70 to 80 "	5
" 80 to 90 "	1
Total	120

Both eyes were affected in 98 cases, one eye only in 22 cases.

Of these cases 69 were under treatment and observation during periods varying from ten days to several years; in 12 of these only one eye was affected.

Color perception was abolished or impaired in 27 of all the cases, and red-green blindness was most prevalent.

Central scotoma was observed in 32 cases. In 21 of these cases alcohol and tobacco were the cause; tobacco alone in 5; tobacco and tabes dorsalis in 1; tobacco, onanism and general debility in 1; alcohol alone in 1; uterine affection in 1; uræmic neuritis from scarlet fever in 1; in one case the cause was unknown.

The pupils showed pathological changes not due to synechiæ in 32 of all the cases. They were inactive in 5 cases; unequal (one-sided mydriasis) in 12 cases; both pupils were mydriatic in 8 cases; myosis was found in 7 of the cases.

Of these seven cases of myosis 3 suffered from tabes dorsalis; one from multiple sclerosis; old age and tobacco alone figured each in one case as the only cause to be detected; and in one case there was a combination of a central lesion with the abuse of alcohol and tobacco.

Contrary to Minor's idea, that in the so-called tobacco amblyopia, tobacco plays no part, since *eight* cases of his improved in spite of their continuing to smoke, I *always* insist in such cases upon *total* abstinence; and I am thoroughly convinced that this is the better way, since I have seen a number of cases beginning to improve only when the patients really abstained totally from the noxious influences. Minor's cases seem to me to prove only that the therapeutic agencies he applied had such a tonic effect on the system of his patients, that they were better able to stand these noxious influences.

In the treatment of all anæmic and atrophic conditions of the optic nerves I have, furthermore, mainly relied upon the use of strychnia. Having formerly once given it up as useless in my hands, I returned to it and found, that, when given more fearlessly and in large enough doses, it well might lead to improvements as had been claimed for it by its introducer, Nagel, and many after him. It is true that an improvement may in many

cases be reached by other remedies, yet never in so rapid, and often astonishing, a manner. It is hardly possible to explain how a drug even when subcutaneously injected, can have so rapid an effect, that sight in some cases after its application may be found to have improved 200 or 300 per cent and even more in the course of five minutes, and yet this does happen and not infrequently so. I have become accustomed to give a very doubtful prognosis in cases of atrophy of the optic nerve in which a trial injection of strychniæ subnitr., gr. $\frac{1}{12}$ or $\frac{1}{15}$ has no effect upon the vision. When vision is somewhat improved after the injection, I increase the dose daily unless the patient complains of headache, dizziness and nausea; and I have in some cases finally injected gr. $\frac{1}{4}$ or even $\frac{1}{3}$ before the patient had any discomfort from it.

A similar treatment has been applied in most of the later cases of the series under consideration and often with a very gratifying and lasting result, and I think it is well to try it in every case for a short period.

In some cases the constant current seemed to act beneficially.

In the cases of congenital atrophy and atrophy from old age, no treatment is apparently of any value.

CORRESPONDENCE.

THE NEW THEORY OF COLOR-PERCEPTION.

WASHINGTON, Aug. 16, 1886.

TO THE EDITOR OF THE AMERICAN JOURNAL OF OPHTHALMOLOGY:

Dear Sir:—There is one paragraph in the interesting and valuable paper by Dr. Fox and Mr. Gould, in the July issue of your JOURNAL, from which a wrong inference might be drawn. They say: (p. 195.)

"Dr. Burnett's reference to Preyer's article in Pflueger's *Archiv* sends us all back to Preyer as the real author of the conception that the retinal function is a refined temperature sense, though so far back as 1877 Pflueger had stated his belief in the phylogenetische Zusammengehoerigkeit des Waerme-und Lichtsinnes."

When the authors wrote this they were acquainted only with my latest utterances on the color question as published in the *Am. Journ. of Med. Science*, for July 1884. With my former publications they were as yet unacquainted; and in order to get this matter as to time of publication set in proper order, I beg leave to state that in 1880 I wrote a paper setting forth the views, substantially, that I now hold, and read it before the Philosophical Society of this city on the 19th of December. An abstract of this paper was published in the *Knapp's Archives* in March, 1881. Preyer's paper did not appear in *Pflueger's Archiv* until May, 1881, so that my publication antedated his by some two months. The original paper as read before the Philosophical Society, was published in full in the *Popular Science Monthly* for May, 1882, and the same ideas were embodied in a lecture at the National Museum, (Saturday Lectures, No. 8) on the 29th of April, 1882. The final summing up, however, was given in the article on "Theories of Color Perception" published in the *Am. Jour. Med. Science*, July, 1884.

It may be proper also to state in this connection, that I never read the whole of Preyer's original article until three weeks ago, my knowledge of it having been obtained through abstracts published in the various journals. With the exception of this point of the analogy of heat and light sensation as manifested through nerves, now having different functions, but originally of the same structure and, probably, function, there is nothing in common in Preyer's views and my own. According to my belief he started out in the proper direction, and pursued it until he came within sight of the truth, and then abruptly turned aside into the devious paths of speculation and unwarrantable physiology and physics.

The analogy of vision and the temperature sense is, however, only a part and the beginning of the basis on which, I believe, the questions of color perception must be wrought out, and I have nowhere seen an approach to such a solution of the question as I have tried to give until the appearance of the paper by Dr. Fox and Mr. Gould.

It should be mentioned, however, that Giraud-Teulon, of Paris, is an earnest opponent of the Young-Helmholtz theory, and inclines strongly to some such explanation as I have given, and has done me the honor to reproduce in his articles a greater part of my paper published in *Knapp's Archives* (see *Annales d'Oculistique*, Jan.-Fev., 1882, pp. 23, 25 and 26; Mars-Avril, p. 124, and *Bull. d. l'Acad. d Méd.*, 46e année, No. 43, 31 Oct., 1882, pp. 1223 and 1230). On the contrary Donders is still a strong adherent to and a stout defender of the Young-Helmholtz theory against all opposition, coming from whatever source it may. His long and laborious articles published of late years in *Graefe's Archiv.* and the *Annales d'Oculistique* are in themselves sufficient evidence of the weakness of his cause, and are quite in contrast to his clear and concise exposition of the laws of refraction and accommodation and their anomalies, which has made him an enduring fame.

But the tide has at last turned, and the current against their impossible theories is so great that the power of tradition, even when supported by the great names of Young, Helmholtz, Donders, and Holmgren, will not be able to withstand it. We must

have a theory of color-perception that is in keeping with our present knowledge of the laws of physics and physiology, and the fact that so many observers (Pflueger, Preyer, Fox and Gould and myself) have independently of each other turned their attention in one direction, is a strong indication that that direction is the one in which future investigation should be prosecuted.

SWAN M. BURNETT.